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Keywords: Blast-furnace slag cement, history, Yawata works, durability, quality, environmental material

1. Introduction
   The blast-furnace slag cement which attracted attention made 100 years eco-friendly cement from the birth recently in JAPAN. I take a look back on a part of history which is technical thing about the blast-furnace slag cement

2. Research initiation
   The hydraulic property of the blast furnace slag was confirmed in 1862. Since then the development of the bonding material that used the blast furnace slag started in foreign countries. In Japan, the blast furnace slag was sub-produced with Governmental Yawata Iron & Steel Work operation from 1901. The research of the blast furnace slag cement began for purpose of effective use sub-product in 1910. When the test result at that time is seen, it is guessed that the reactivity of the blast furnace slag was low. Because the chemical composition was more than now SiO₂, and was few CaO. Therefore, the slag basicity that is the index of strength was considerably small compared to about 1.4-1.5 and present 1.8.

3. Blast-furnace slag cement of Taisho Period
   Y reservoir dam is concrete dam that completed in October, 1927 and passes about 80 years. When the blast-furnace slag particle in the concrete core of this dam was observed by scanning electron microscope, a part of it was unhydrated. It is shown that SEM image in core 80 years ago in Fig.1. We will continue the investigation whether the hydration of blast-furnace slag in dam which passed 80 year is stops or proceeds if there is a chance in the future.

   At that time, the blast furnace cement was able to be used almost as well as the ordinary portland cement. Moreover, it is interesting that the importance of curing has already been described.

4. Approach to technical problem for popularize in our company
   4.1 Quality stability
   Currently, the blast-furnace cement ensures the strength appearance by enlarging fineness more than the ordinary portland cement. But, An increase in a further fineness is not good from the viewpoints of heat, flow, and etc. Strength is made to be raised to some extent, and our company is stability of the quality by the separated crushing method.

4.2 Evaluation of durability
   Our company has advanced to research that Neutralization as bad points, Salt Damage and Alkali Silica Reaction as good points.

5. The future of blast furnace slag cement
   It is shown to the development of the blast furnace cement in the future. (1) The method of evaluating an environmental material is not clear. It should be that constant evaluation method is established (2) It takes a long time for the evaluation for durability. I think that the long term research is necessary for the inheritance to successor. (3) In the U.S. and Europe, the blast furnace slag cement is said that there is a controlling effect on the heat island from the performance. Because, the blast furnace slag cement is whiter than ordinary portland cement. This way, the engineer should keep having a fresh sensitivity.

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Commentaries

Technological History of Blast Furnace Cement
—history of 100 years—

Yasuhiro DAN*¹ and Shinya HIRAMOTO*²

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Commentaries

Committee Activities for the Next Revision of JSCE Concrete Code

Kyuichi MARUYAMA*

Keywords: JSCE Concrete Code, revision, history of JSCE Concrete Code, enquiry, technical problems, future roles

JSCE published a concrete code firstly in 1931. Since then, the concrete code has been revised and published every five years. The allowable stress design method had been used until the limit states design method was introduced in 1986.

For the first fifty-five years the code contained all necessary requirements in one volume. Then, the introduction of limit states design method in 1986 made the contents of design part expanded largely. As the results, the code was divided into four volumes.

The trend of expansion of pages in each volume is shown in Fig.1. Before 1986, the main efforts of the code revision committee were devoted to the field of materials and construction, not so much to design.

Durability problems, such as the damage due to salt attack and alkali aggregate reaction reported in 1980'-1990's, and the damage due to the Great Hanshin Earthquake in 1995 gave engineers strong impacts to pursue more effective techniques on concrete structures. Then, JSCE Committee on Revision of the Standard Specifications for Concrete Structures (code revision committee) decided to expand the coverage of code.

Extending the concept of limit states, the design method has come to verify the required performance. Consequently, the contents of the code in 2002 increased in pages to include relevant methods of verification to requirements.

The code revised in 2007 was intended to be more rational and to be user friendly. Some parts in the volume of construction were moved to the volume of design. Furthermore, the frame work of each volume was restructured in three parts, such as “basics”, “standards”, and “typical applications”. These resulted in increase of pages of the code.

The code revision committee set three major tasks in the first two years (2008-2009) before starting the works for the next revison of code in 2012. The first task was to survey what engineers in Japan think about the revised version of JSCE concrete code in 2007. Using internet media an inquiry sheet with more than 15 items to answer was delivered to engineers in private companies as well as those in governmental authorities. More than 600 inquiry sheets were collected. In general, the code in 2007 is welcome to most engineers.

The second task was to review what problems were left unsolved in 2007 code, and what technical solutions should be added in the code near future. Shrinkage of concrete has become a major topic since severe crack damage of structures was reported in 2007. The reduction of performance due to severe environmental actions should be properly evaluated and relevant counter measures should be introduced.

The third task was to make a new trial volume which covers whole life of concrete structures, form the design process at the first stage to the maintenance and repair including demolition at the last stage. In addition, it should tell engineers how the volumes of design, materials and construction, maintenance are used at each stage.

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Keywords: ISO 22966, execution, concrete structures, execution class, quality mark, maximum allowable deviations

In ISO/TC71/SC3, ISO 22966 (Execution of concrete structures) was approved at 3rd September 2009 after FDIS voting and was published at 9th November 2009.

This International Standard gives common requirements for execution of concrete structures to achieve the intended levels of reliability and serviceability that are given in ISO 2394 (General principles on reliability for structures). In particular, this standard gives requirements for the execution of structures intended to fulfill the requirements from the design with respect to adequate strength and durability. This standard expects also the execution specification to state all the specific requirements relevant to the particular structure and is applicable to temporary as well as permanent concrete structures.

ISO 22966 does not cover the specification, production and conformity of concrete. This standard is not applicable to the production of precast concrete elements made in accordance with product standards. This standard does not cover the requirements for concrete members in special geotechnical works such as pile foundations, ground anchors, slurry walls, etc and does not also cover safety and health aspects of execution, or third party safety requirements. ISO 22966 does not also cover contractual issues or responsibilities for the identified actions.

Requirements for quality management are specified using one of the three execution classes. The execution class being used shall be stated in the execution specification. Products bearing a recognized quality mark or certified by an approved certification body shall be checked against the delivery ticket. The completed structure shall be within the maximum allowable deviations which are permitted in detail in Chapter 10. These three main requirements shall be harmonized in Japanese execution specifications in the near future.

This International Standard assumes the following as a) the availability of a comprehensive design of the structure, b) a project management in charge of the supervision of the works which will enable the execution of a conforming structure, and c) a site management which will take charge of the organization of the works and enable the correct and safe use of the equipment and machinery, the satisfactory quality of materials, the execution of a conforming structure and its safe use up to the delivery of the works.

ISO 22966 presupposes that the work is carried out with the necessary skill and adequate equipment and resources to perform the work in accordance with this International Standard and the requirements of the execution specification.

It is assumed that the constructor will comply with national regulations and standards e.g. with respect to a) quality management, b) qualifications for the personnel doing the various activities covered by this standard, c) health and safety aspects of construction, and d) environmental aspects. This standard assumes that the finished structure after completion is used as intended in the design and submitted to the planned inspection and maintenance necessary to achieve the intended design working life and to detect weaknesses or any unexpected behavior.

Table 1 ISO 22966 (Execution of concrete structures)

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Seamless Water Content Measurement Using Radio Isotope Moisture Meter
- at a repair work for earth quake resistance -

Takayuki INOUE*1, Shigeki SEKO*2, Hiroshi SUZUKI*3 and Satoshi NAKAJIMA*4

Keywords: radio isotope moisture meter, concrete, water content, seamless monitoring

Water content of ready mixed concrete affects strength and durability of hardened concrete. So, it is important to monitor water content when ready mixed concrete is placed at a construction site.

In this report, radio isotope (RI) moisture meter that enables to measure water content of ready mixed concrete through the pumping pipe is adopted as shown in Fig.1 and Photo 1 introducing characteristic behavior of neutron that its energy is heavily damped by hydrogen atom. Water content can be computed with the meter seamlessly and in real-time working out the ratio of measured fast neutron count which is not damped but passed through concrete to standard fast neutron count.

Measured water content of concrete in a repair work for earth quake resistance is presented in this report. The amount of concrete placed in the work was about 13,000m³ which were manufactured at four ready mixed concrete plants, with two different compositions, and the measurement was practiced on 10,000m³ of it. The water content of the concrete was measured with two different methods. One was RI moisture meter method and the other was microwave oven dry method to calibrate the result measured with RI moisture meter method.

Water content measured with RI moisture meter during a day is shown in Fig.2. As it’s shown, water content process of the whole concrete was seamlessly measured successfully. The variance of measured water content from design was within -3kg/m³ and +2kg/m³ in average among the four concrete plants.

Effectiveness to adopt RI moisture meter to verify seamlessly quality of whole concrete placed was confirmed according to the result of measurement. Then utilizing this effective point, an upper limit of water content was set in the work to control the quality of the concrete. Concrete had to be returned to the plants once measured water content transgressed the upper limit. As a result, measured water content of whole concrete during the work was within +15kg/m³ and 0kg/m³ meaning the variance was small enough. The result of compressive strength test in average among the four plants was higher enough than design, and standard deviation of the compressive strength was small enough.

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Keywords: UFC, ultra-high strength, fiber reinforced, precast, slab, pre-tension, mass-production

About 7,000 Ultra-high strength Fiber reinforced Concrete (UFC) precast slabs were installed in the area around Runway D and its taxiways at Tokyo International Airport (Haneda). The UFC slabs are required to carry heavy loads, such as a jumbo jet, and must be cost-competitive. Therefore, experiments in mass production, as well as structural tests, were conducted with various types of UFC slabs.

As a result, a two-direction pre-tensioned UFC slab with a rib structure (Fig.1) and its mass-production system were developed. The structure of UFC slab was a highly prestressed structure, and achieved a drastic weight deduction (i.e. 56%) compared with a conventional concrete slab. Load tests using full size slabs were carried out in order to confirm its load capacity. As a test result shown in Fig.2, the UFC slabs satisfy the required performance, and can endure two times of a jumbo jet load.

A dedicated UFC slab factory incorporating the mass production system was constructed. That factory had two production lines, and each line had 20 steel forms and two-direction pre-tension facilities (Fig.3). Various devices for the efficiency improvement of mass-production were included in the steel form. The production rate, therefore, was 80 slabs per week, and 7,000 high quality UFC slabs were cost-effectively produced.

This is the first time in the world for UFC structures to be produced on such a large scale. It is no exaggeration that the UFC technology obtained from much research and development in Japan is the forefront of technology in the world.
**Keywords:** pneumatic caisson, high early strength concrete, mass concrete, embedded pipe cooling

In the bridge infrastructure construction work for Bridge No. 1 of the Inan bypass of route 153, its pier foundations were constructed using the pneumatic caisson method. The pile cap of each pier foundation, 3.5 m in thickness, constituted mass concrete. Since high early strength concrete was to be used in this portion, possible cracking therein due to thermal stress was a major concern from the beginning. As a countermeasure, cooling the concrete with embedded water pipes was planned based on results of thermal stress analysis of a construction experiment using a test structure.

In pneumatic caisson method, a work chamber is set up beneath the bottom of the caisson. This enclosed space is pressurized with compressed air to keep water out at depth. Excavation work is then carried out in this chamber, and a caisson built on the ground is sunk in steps into the ground.

When cooling the concrete with embedded water pipes, it is most important to arrange them in the concrete accurately and to control the temperature and volume (flow) of the water. In fact, in the construction work under discussion here, it became a major challenge to do this. The pile cap, comprising many reinforcing bars, required cooling pipes about 1100 meters in total length. The installation work for the pipes was truly labor-intensive and time-consuming. Water flow was controlled by four pumps supplying water through 28 water inlets. An ingenious scheme was used where water was supplied via a manifold pipe connected to a pump so that the same amount of water could be supplied to individual pipes. Temperature histories measured at the top of the pile cap and near the bottom of the pier, where cracks were likely to be generated, were roughly equivalent to those obtained in the analysis of the experiment. This result confirmed the effectiveness of the embedded cooling pipes. Also, concrete forms for the bottom portion of the pier were left in place for a long time to protect the portion. Partly due to this measure, no cracking was observed after the construction was completed.

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Construction records

Ultra-short Construction Period by Full Pre-cast Construction Method and Floor Climbing Tower Crane for Super High-rise Reinforced Concrete Housing

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Keywords: super high-rise reinforced concrete housing, pre-cast method, floor climbing method, floor climbing tower crane

This building is super high-rise reinforced concrete housing with 35 floors above and 1 floor below the ground and a slender structure with its aspect ratio of approx. 5.0 due to some restrictions such as site conditions, etc. The structure is Rahmen type with three types of quake-controlling systems installed. For the purpose of achieving high quality, shorter construction period and cost reduction, joint parts of girder and column are pre-cast as well as columns, girders and floors are. In addition, a floor climbing tower crane, which has been seldom used for reinforced concrete structure, was adopted due to the site conditions. Here is the outline of the ultra-short construction period of four days per floor by adopting the pre-cast method and the floor climbing tower crane.